Designation: D6210 – 10

Standard Specification for Fully-Formulated Glycol Base Engine Coolant for Heavy-Duty Engines[1,2]

This standard is issued under the fixed designation D6210; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This specification covers the requirements for fully-formulated glycol base coolants for cooling systems of heavy-duty engines. When concentrates are used at 40 to 60 % glycol concentration by volume in water of suitable quality, (see Appendix X1), or when prediluted glycol base engine coolants (50 volume % minimum) are used without further dilution, they will function effectively during both winter and summer to provide protection against corrosion, cavitation, freezing, and boiling.

1.2 This specification is intended to cover the requirements for engine coolants prepared from virgin or recycled ethylene or propylene glycol.

NOTE 1—Committee D15 has not substantially studied the impact of using recycled glycols from sources such as:

- glycol bottoms
- polyester manufacturing waste
- aircraft and runway deicers
- medical waste

to prepare engine coolants. However, several serious cases of very poor performance have been reported and substantiated in heavy duty fleets when recycled glycols from sources such as above have been used to prepare engine coolants. Efforts are underway to more clearly define the purity requirements for glycols used to prepare engine coolants meeting this specification, whether from recycled engine coolants or other sources.

1.3 The coolants governed by this specification are categorized as follows:

Coolant Type	Description
I-FF	Ethylene glycol base concentrate
II-FF	Propylene glycol base concentrate
III-FF	Ethylene glycol predilute (50 vol %)
IV-FF	Propylene glycol predilute (50 vol %)

1.4 Coolant concentrates meeting this specification do not require any addition of Supplemental Coolant Additive (SCA) until the first maintenance interval when a maintenance dose of SCA is required to continue protection in certain heavy duty engine cooling systems, particularly those of the wet cylinder liner-in-block design. The SCA additions are defined by and are the primary responsibility of the engine manufacturer or vehicle manufacturer. If they provide no instructions, follow the SCA supplier's instructions.

1.5 The values stated in SI units are to be regarded as standard. The values given in parentheses are for information only.

1.6 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 *ASTM Standards:*[3]

D1126 Test Method for Hardness in Water
D1293 Test Methods for pH of Water
D3306 Specification for Glycol Base Engine Coolant for Automobile and Light-Duty Service
D4327 Test Method for Anions in Water by Suppressed Ion Chromatography
D5828 Test Method for Compatibility of Supplemental Coolant Additives (SCAs) and Engine Coolant Concentrates
D7583 Test Method for John Deere Coolant Cavitation Test

2.2 *Other Standards:*[4]

Federal Method 2540B Total Dissolved Solids Dried at 103–105°C

3. General Requirements

3.1 Concentrated and prediluted coolants shall meet all of the physical, chemical and performance requirements of Specification D3306., Tables 1, 2, and 3.

[1] This specification is under the jurisdiction of ASTM Committee D15 on Engine Coolants and Related Fluids and is the direct responsibility of Subcommittee D15.07 on Specifications.

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[2] A research report is available from ASTM International Headquarters. Request RR:D15-1023.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

[4] Standard Method for the Examination of Water and Wastewater, American Public Health Association, et al, 1015 15th Street, N.W. Washington, DC 20005

***A Summary of Changes section appears at the end of this standard**

3.2 The coolant concentrate mixed with water or the prediluted coolant, when maintained with maintenance doses of SCA in accordance with the engine manufacturer's recommendations, and those on the product label, shall be suitable for use in a properly maintained cooling system in normal service for a minimum of two years (see Appendix X1).

4. Additional Requirements

4.1 The coolant concentrate or prediluted coolant additionally shall provide protection in operating engines against cavitation corrosion (also termed liner pitting) and against scaling of internal engine hot surfaces. Hot surfaces typically are within the engine head, head spacer, upper cylinder liner, or liquid cooled exhaust manifold. ASTM has test methods under development for both cavitation corrosion and hot surface scaling. Until these procedures are approved as ASTM standards, the mandatory requirements of Annex A1 shall apply.

4.2 Lack of compatibility between the coolant and SCA product's chemistry may cause the solute to precipitate out of solution, with potential adverse effects in the vehicle or engine cooling system. A test procedure for compatibility (Test Method D5828) has been developed and approved. The compatibility of SCA and coolant concentrate solutions meeting this specification shall be determined using D5828 and the results reported.

4.3 Both the concentrated and prediluted coolants shall contain less than 50 µg/g sulfate ion.

5. Keywords

5.1 cavitation; fully-formulated heavy-duty engine coolant; supplemental coolant additive maintenance dose

ANNEX

(Mandatory Information)

A1. REQUIREMENTS FOR FULLY FORMULATED HEAVY DUTY ENGINE COOLANT

A1.1 Laboratory data or in-service experience demonstrating a positive influence on reducing cavitation corrosion in an operating engine is required. See Table A1.1.

A1.1.1 In-service qualification tests may consist of single- or multiple-cylinder engine tests. At the option of the engine or vehicle manufacturer, such testing may be conducted in "loose engines" or in engines fully integrated into an application, such as a vehicle, a power boat, or a stationary power source. One such test has been developed.[5]

TABLE A1.1 Cavitation Protection Options Meeting the Requirements of A1.1

Utilize one of the Following	Prediluted or Concentrate	Acceptance Criteria
In-service test	per agreement	agreement between engine manufacturer and coolant supplier for test criteria
Laboratory test (D7583)	per tested formulation	maximum 200 pit count measured per Test Method D7583
Chemical Composition		
Nitrite formulation	prediluted	nitrite (as NO_2^-) of 1200 µg/g (ppm) minimum
Nitrite formulation	concentrate	nitrite (as NO_2^-) of 2400 µg/g (ppm) minimum
Combined nitrite and molybdate formulation	prediluted	combined concentration of nitrite (as NO_2^-) plus molybdate as (MoO_4^{-2}) of 780 µg/g (ppm) minimum. At least 300 µg/g (ppm) each of NO_2^- and MoO_4^{-2} must be present
Combined nitrite and molybdate formulation	concentrate	combined concentration of nitrite (as NO_2^-) plus molybdate (as MoO_4^{-2}) of 1560 µg/g (ppm) minimum. At least 600 µg/g (ppm) each of $NO_2^-$and MoO_4^{-2} must be present

A1.1.2 Coolants that have completed the Test Method D7583 (laboratory test method to demonstrate coolant cavitation performance) test with a maximum pit count of 200 are regarded as passing the requirements of A1.1.

A1.1.3 Several chemical compositions have been tested extensively by producers and users and satisfactorily minimize cylinder liner cavitation in actual test engines. Coolants meeting either of the following compositions are regarded as passing the requirements of A1.1:

A1.1.3.1 A minimum concentration of nitrite (as NO_2^-) of 1200 µg/g (ppm) in the 50 volume % prediluted coolant, or

A1.1.3.2 A minimum combined concentration of nitrite (as NO_2^-) plus molybdate (as MoO_4^{-2}) in the 50 volume % prediluted coolant of 780 µg/g (ppm). At least 300 µg/g (ppm) each of NO_2^- and MoO_4^{-2} must be present.

A1.1.3.3 The above concentrations are doubled for coolant concentrates.

A1.2 Both concentrated and prediluted coolants under this specification must contain additives to minimize hot surface scaling deposits. Certain additives (polyacrylate and other types) minimize the deposition of calcium and magnesium compounds on heat rejecting surfaces. No specific chemical

[5] "A Comparison of Engine Coolant in an Accelerated Heavy-Duty Engine Cavitation Test," SAE Technical Paper 960883, SAE International, 400 Commonwealth Drive, Warrendale, PA 15096–0001.

requirements for hot surface scaling and deposits resistance have been established at this time. A test procedure is under development and will be incorporated into the specification when a procedure is approved by ASTM.

APPENDIX

(Nonmandatory Information)

X1. COOLANT MAINTENANCE FOR HEAVY DUTY ENGINES

X1.1 *Engine Coolant*—Cooling system fill for a heavy duty engine consists of water and fully formulated heavy duty coolant concentrate or fully formulated prediluted heavy duty coolant.

X1.1.1 *Water:*

X1.1.1.1 Water quality affects the efficiency of coolant additives. When untreated, all water is corrosive. Water having a high mineral content or corrosive materials is unfit for cooling system use.

X1.1.1.2 When preparing coolant mixtures, the water should be of such quality that it does not contain excessive solids, hardness salts, sulfates, or chlorides. In the absence of specific recommendations from the engine or vehicle manufacture, see Table X1.1. Contact your local water department, the responsible government agency, or submit a water sample for analysis if there is a question on water quality.

X1.1.2 *Coolant Concentrates:*

X1.1.2.1 The coolant concentration should be maintained between 40 and 60 % glycol by volume, depending on the engine operating environment. Freeze protection will be provided in accordance with Table X1.2.

X1.1.3 *Prediluted Engine Coolants:*

X1.1.3.1 Prediluted glycol base engine coolants (50 volume % minimum) should be used without further dilution. If additional freeze protection is required, coolant concentrate may be added to the prediluted engine coolant to increase the total glycol content in the cooling system (see Table X1.2)

X1.1.4 *Supplemental Coolant Additive:*

X1.1.4.1 SCAs extend the life of the coolant by replenishing the additives that deplete during normal operation. SCAs, however, do not extend the freeze protection provided by the coolant concentrate.

TABLE X1.1 Suggested Water Quality Limits[A]

Property	Specific Values	Test Method
Total solids, µg/g (ppm (grains/gal))	340 (20) max	Fed Method 2540B[B]
Total hardness, µg/g (ppm (grains/gal))	170 (10) max	D1126
Chloride (Cl), µg/g (ppm (grains/gal))	40 (2.4) max	D4327
Sulfate (SO_4), µg/g (ppm (grains/gal))	100 (5.9) max	D4327
pH	5.5 to 9.0	D1293

[A] Adopted from a survey by the D15 Water Quality Task Force.
[B] Federal Method 2540B, "Total Dissolved Solids Dried at 103–105°C."[4]

TABLE X1.2 Freeze Protection

	Approximate Freeze Protection Temperature, °C (°F)	
Glycol Content, %	Coolant Type I-FF	Coolant Type II-FF
40	–24 (–12)	–21 (–6)
50	–37 (–34)	–32 (–26)
60	–52 (–62)	–48 (–54)

X1.1.4.2 Heavy-duty engine users experience has shown that coolants not meeting the criteria specified in A1.1 may not provide long term protection against cavitation corrosion (liner pitting). User experience and published information shows the presence of nitrite in an SCA or fully-formulated heavy-duty coolant is particularly effective in providing maximum protection.

X1.1.4.3 New technology consisting of other chemistries may provide satisfactory protection. Such chemistries can be established by agreement between producers and users upon demonstration of performance utilizing Test Method D7583. Optionally, such demonstrations can consist of comparative damage rating from testing in operating engines. One or both of these options may be applied as determined in a specific agreement between parties.

X1.2 *Coolant Maintenance Recommendations*:

X1.2.1 If any of the following recommendations differ, follow the engine or vehicle manufacturer's recommendations.

X1.2.2 Use the coolant concentration recommended in this specification.

X1.2.3 Drain and flush the cooling system as recommended by the engine or vehicle manufacturer.

X1.2.4 Use water that meets the requirement in Table X1.1.

X1.2.5 Use accurate, reliable equipment, such as a refractometer, to measure coolant concentrate levels for freeze protections.

X1.2.6 Use the SCA manufacturer's recommended test kit when testing the coolant for proper additive concentration. Test kits shall indicate the degree of liner pitting protection present in the coolant.

X1.2.7 Check freezing point at two different levels when coolant concentrate and water is premixed and stored in bulk or drums to be sure mixing is complete before use.

X1.2.8 Use coolant mixed at the desired proportions for make-up.

X1.2.9 Use SCAs at the recommended maintenance dosage and intervals to control deposits, corrosion, water pump damage, and liner pitting.

X1.2.10 Periodically check bulk premixed coolant storage tanks for separation of chemicals and contamination.

X1.2.11 DO NOT add undiluted coolant concentrate as make-up coolant for coolant Types I-FF and II-FF.

X1.2.12 DO NOT add plain water as make-up coolant.

X1.2.13 DO NOT exceed 60 % coolant concentrate in Type I-FF and Type II-FF coolants. A coolant concentrate level greater than 68 % actually reduces freeze protection in ethylene glycol base coolants. The maximum recommended coolant concentrate level is 60 % which provides the freeze protection shown in X1.1.2.

X1.2.14 DO NOT exceed the manufacturer's recommended dosage of SCA or the recommended concentration of coolant concentrate. Over-concentration can result in plugged radiators, heater cores, and charge air coolers and can also cause water pump seal leaks.

X1.2.15 DO NOT reuse coolant that has been drained from a vehicle.

X1.2.16 DO NOT precharge the cooling system with SCA when using fully-formulated heavy-duty engine coolant.

X1.2.17 DO NOT use soluble oil additives.

X1.2.18 DO NOT use methyl alcohol or methoxypropanol base coolant concentrates.

X1.2.19 DO NOT use anti-leak additives if engine cooling system is equipped with a coolant filter, as this may plug the filter element. For all other cooling systems, follow the recommendations of the engine or vehicle manufacturer.

SUMMARY OF CHANGES

Committee D15 has identified the location of selected changes to this standard since the last issue (D6210–08) that may impact the use of this standard.

(1) The newly adopted ASTM Test Method D7583 was added to the list of referenced documents.
(2) The word "Chemical" was removed from the title of Annex A1.
(3) New Section A1.1.2 was added to provide the option to utilize results from Test Method D7583 to demonstrate acceptable cavitation protection and subsequent sections were renumbered.
(4) Section A1.3: Language regarding replacement of the chemical composition being removed when a test method becomes available was deleted.
(5) Table A1.1 was added to clarify options available to demonstrate compliance with A1.1.
(6) Sections in the annex were renumbered.
(7) Language was clarified in X1.1.4.2 and X1.1.4.3 providing the option to demonstrate acceptable cavitation protection specified in Annex A1.
(8) Language was added in X1.1.4.3 providing the option to demonstrate acceptable cavitation protection through Test Method D7583 specified in A1.1.2.